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Longitudinal Dynamics Systems

Model: E70

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the integration of ABS, DSC, EMF and DCC in Longitudinal Dynamics System.
- Describe the operation of Longitudinal Dynamics System.
- Identify the components that operate Longitudinal Dynamics System.

Introduction

Longitudinal Dynamics Systems

By applying today's standard consideration aspects, subdividing the functions of driving dynamics systems into the three co-ordinate axes results in the use of three different systems that belong to longitudinal dynamics on the E70.

Longitudinal dynamics systems (effective direction mainly on the x-axis or longitudinal axis):

- (ABS) Anti-lock braking system
- (DSC) Dynamic stability control
- (EMF) Electromechanical parking brake
- (DCC) Dynamic cruise control (cruise control with brake intervention)

ABS in DSC

The ABS prevents the wheels locking while braking and therefore ensures that the vehicle stays on track and can be steered in critical situations.

ABS is constantly activated during vehicle operation and cannot be switched off by the driver. The four wheel speed sensors send data to the DSC control unit that monitors the speed of each wheel. If one or several wheels decelerate at a faster rate than permitted, the DSC control unit activates the hydraulic unit, which in turn reduces the hydraulic pressure in the corresponding brake line. The DSC control unit and the hydraulic unit make up one assembly.

When the DSC control unit requests intervention of the antilock braking system, it activates the inlet and outlet solenoid valves in the hydraulic unit of the affected brake line and switches on the return pump. The inlet valve closes in order to disconnect the brake line(s) from the master brake cylinder and the outlet valve opens to allow the brake fluid of the affected brake circuit to escape into the reservoir in order to reduce the pressure in the circuit. Consequently, the braking effect is reduced and the wheel begins to turn. The DSC control unit then opens and closes the inlet and outlet valves in such a way as to ensure the optimum braking pressure is built up at each wheel without the wheels locking. The return pump conveys brake fluid from the equalizing reservoir of the master brake cylinder, thus maintaining a constant brake fluid pressure downstream of the inlet valves so that the pressure in the brake lines is immediately re-established when the inlet valves are open again.

In the case of braking with ABS assistance, the driver normally obtains feedback in the form of pedal vibration and the noise of solenoid valves or the pump. This is reduced to a minimum by the high-performance hydraulic unit of the DSC E7x in the E70.

Dynamic Stability Control (DSC)

The E70 is equipped with a new generation of the dynamic stability control system.

Note: To date, the DSC driving dynamics system on all-wheel drive vehicles was referred to with the abbreviation "DXC".

Since this led to confusion with the xDrive, in the future the dynamic stability control system will be known as DSC also on all-wheel drive vehicles.

This new generation of the dynamic stability control (DSC E7x, supplied by Bosch) in the BMW X5 is actually the only driving dynamics system that covers all three areas of longitudinal, transverse and vertical dynamics with its control intervention functions and its modular functional structure.

With its varied control strategies, the DSC ensures outstanding driving stability within physical limits, active safety and excellent traction in all driving situations.

Electromechanical Parking Brake (EMF)

The electromechanical parking brake was used for the first time at BMW on the E65 (7 Series).

In principle, the task of the parking brake is to secure the stationary vehicle to prevent it rolling away. The parking brake firmly holds the parked vehicle. In contrast to the parking brake that to date was based on a pure mechanical hand brake and foot brake system, the EMF is designed as an automated, comfort-oriented parking brake system where the driver can apply and release the parking brake by the push of a button.

The design layout of the parking brake system is in keeping with typical BMW requirements:

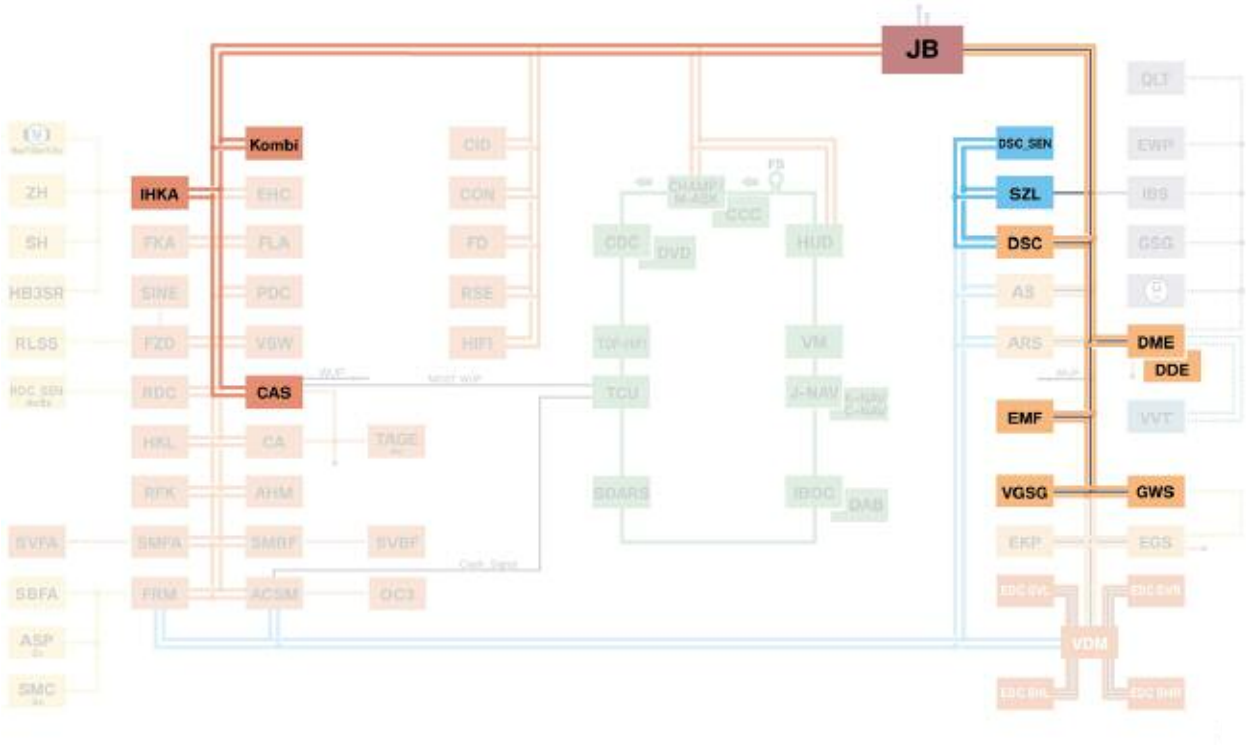
- Exclusion of all safety-critical situations
- Optimum functionality
- Maximum system availability
- High degree of comfort and convenience

Besides complying with the legal requirement of mechanically holding the parked vehicle and providing an independently operable parking brake in addition to the service brake, one of the main advantages of the EMF is that it enables dynamic braking with DSC control.

Dynamic Cruise Control (DCC)

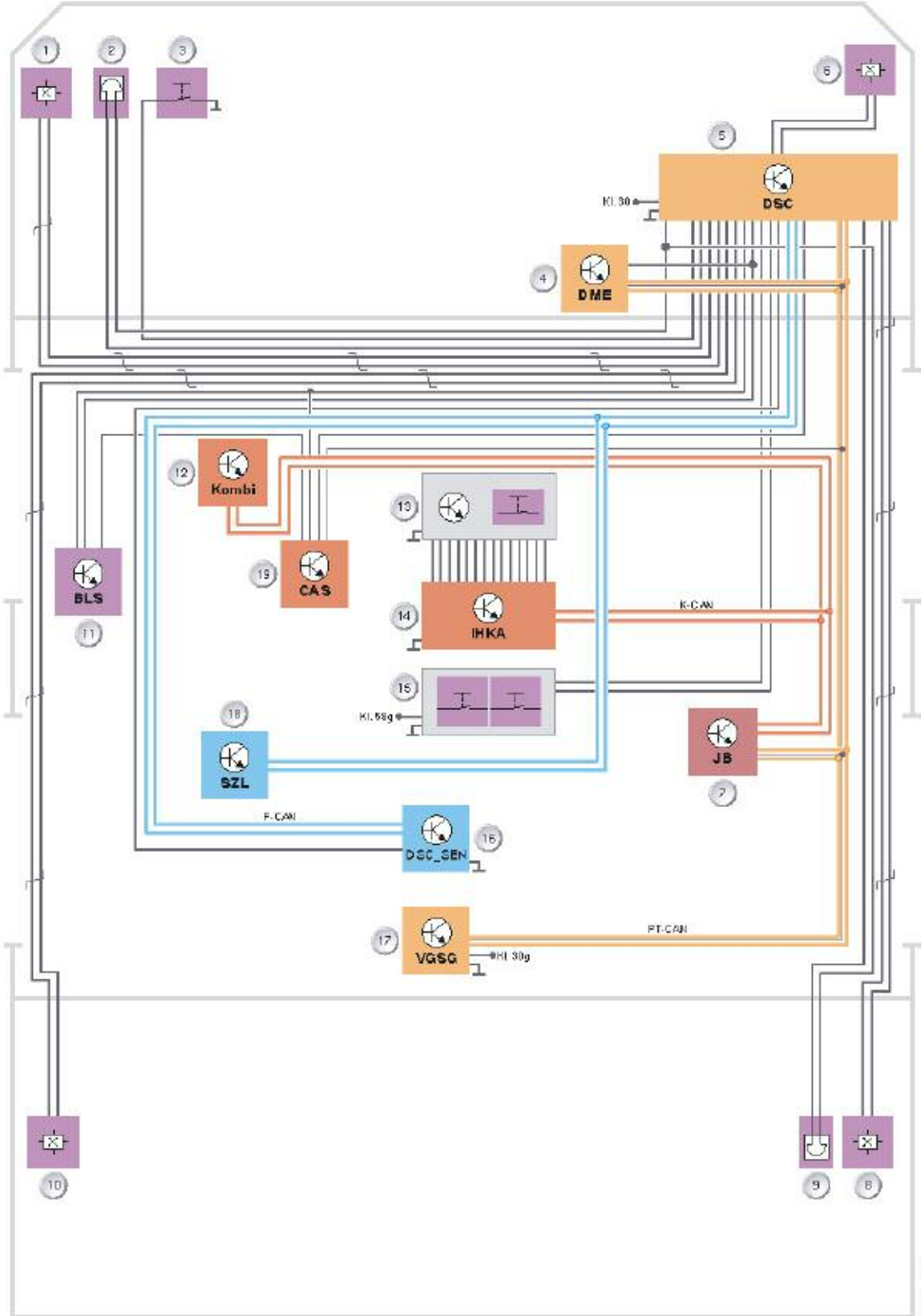
The dynamic cruise control is a conventional cruise control system (Tempomat) which features additional functions including active brake intervention. Cruise control with brake intervention (DCC) was introduced for the first time at BMW on the E90 (3 Series).

DSC Bus Overview



Index	Explanation	Index	Explanation
KOMBI	Instrument cluster	DSC	Dynamic stability control
IHKA	Automatic climate control	DME	Digital motor electronics
CAS	Car Access System	EMF	Electromechanical parking brake
JB	Junction box	VGSG	Transfer box control unit
DSC_SEN	DSC sensor	GWS	Gear selector lever
SZL	Steering column switch cluster		

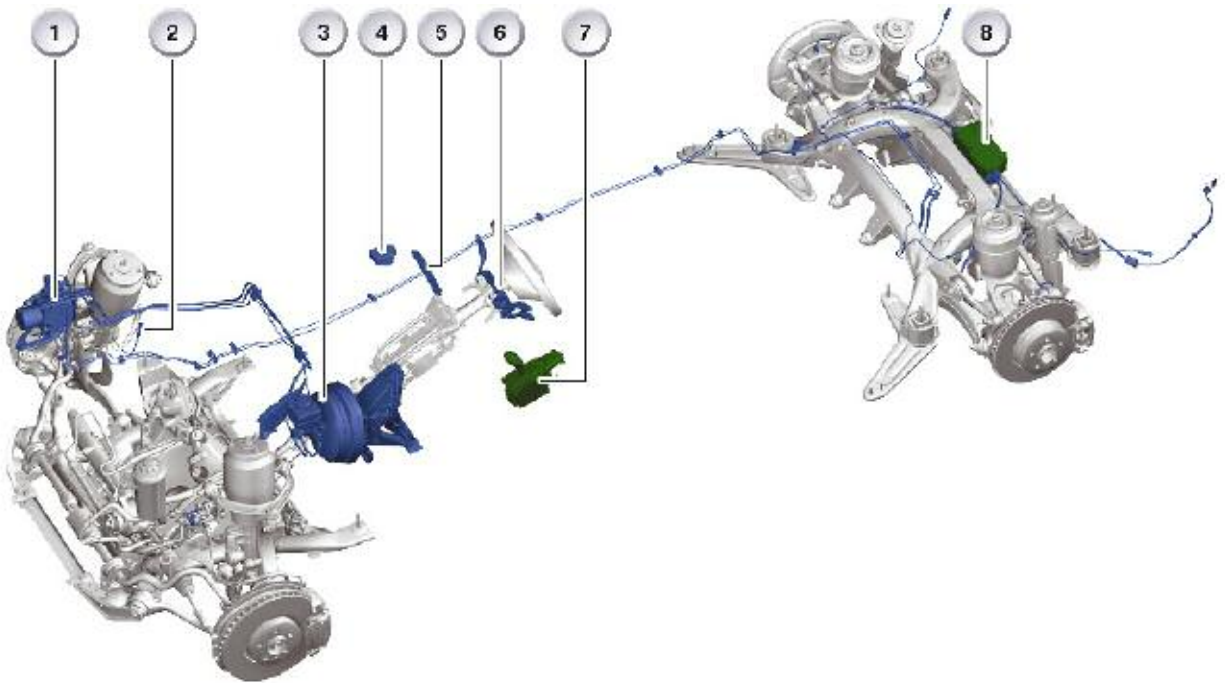
DSC Circuit Diagram



Legend for DSC Circuit Diagram

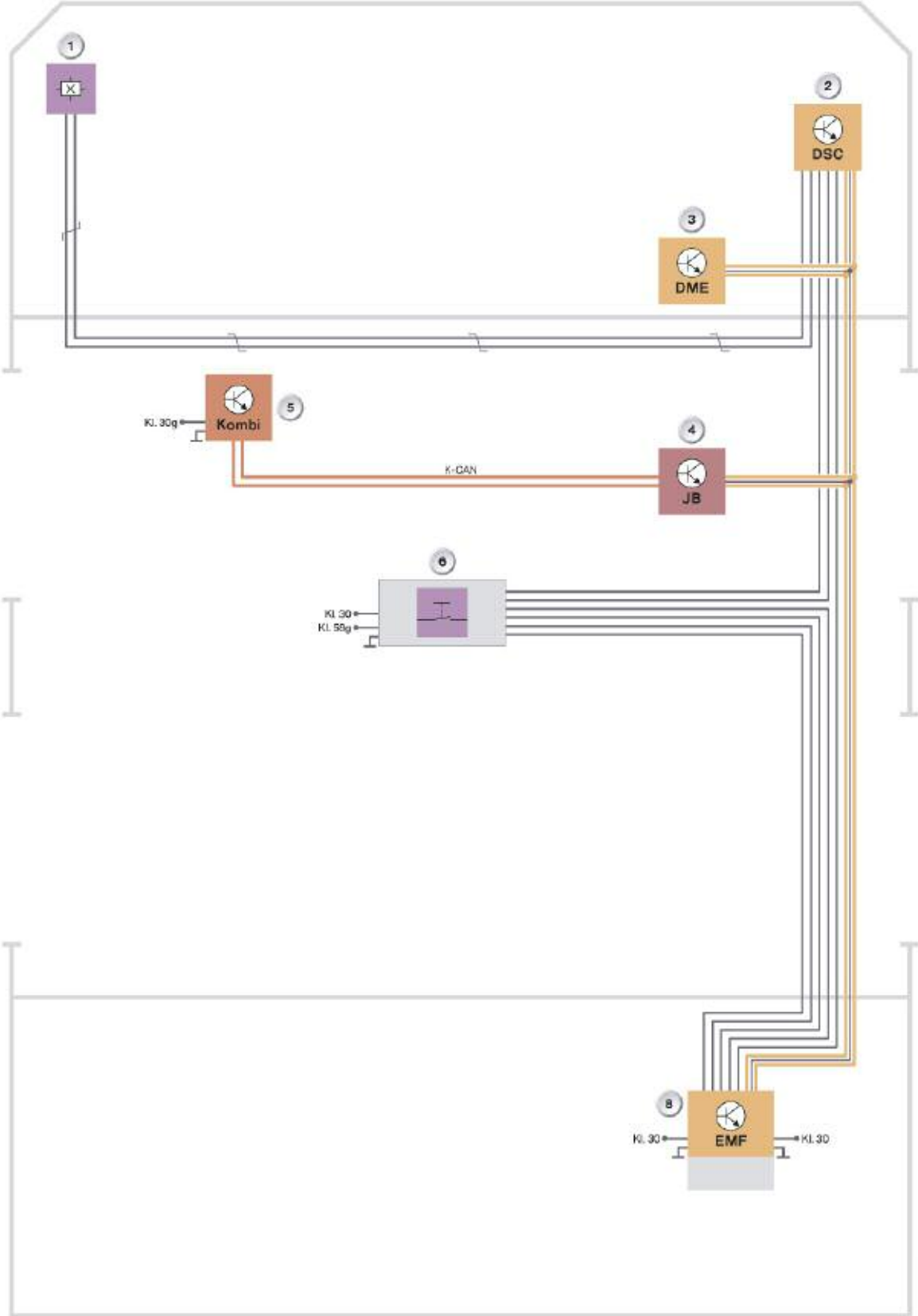
Index	Explanation	Index	Explanation
1	Wheel-speed sensor, front left	11	Brake light switch
2	Brake pad wear indicator, front left	12	Instrument cluster
3	Brake fluid level sensor	13	Center console switch cluster
4	Digital motor electronics	14	Automatic climate control
5	Dynamic stability control	15	Gear selector lever
6	Wheel-speed sensor, front right	16	DSC sensor
7	Junction-box ECU	17	Transfer box control unit
8	Wheel-speed sensor, rear right	18	Steering column switch cluster
9	Brake pad wear indicator, rear right	19	Car Access System
10	Wheel speed sensor, rear left		

DSC System Overview



Index	Explanation	Index	Explanation
1	Hydraulic unit with DSC control unit	5	Center console switch cluster
2	Wheel speed sensor (4x)	6	Steering column switch cluster
3	Master brake cylinder	7	Gear selector lever
4	DSC sensor	8	EMF actuating unit

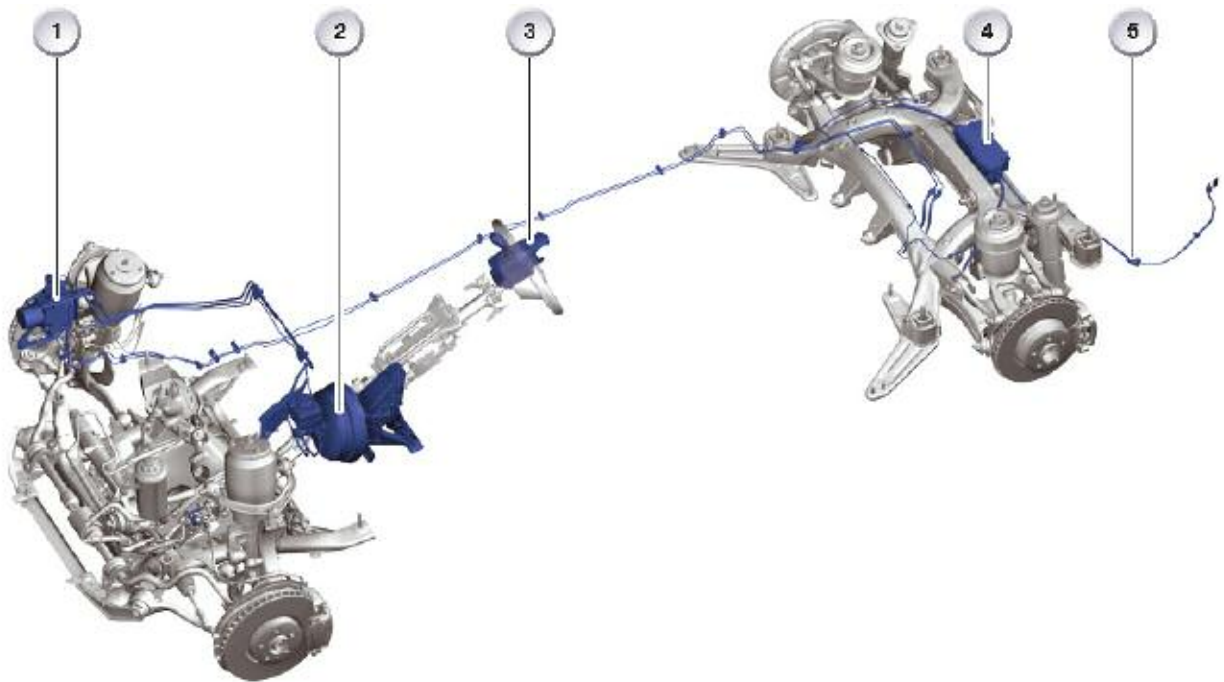
EMF Schematic Circuit Diagram



Legend for EMF Schematic Circuit Diagram

Index	Explanation	Index	Explanation
1	Wheel-speed sensor, front left	5	Instrument cluster
2	Dynamic stability control	6	Gear selector lever
3	Digital motor electronics	7	EMF actuating unit
4	Junction-box ECU		

EMF System Overview



Index	Explanation	Index	Explanation
1	Dynamic stability control	4	EMF actuating unit
2	Master brake cylinder	5	Emergency release EMF
3	Gear selector lever		

New Features of the DSC E7x

The system supplier for the DSC E7x is Bosch. With its optimized control functions, the new system design makes a significant contribution to increased driving dynamics. Additional functions for active safety and additional comfort have been implemented in the new system. The new system in the E70 offers the following advantages:

- Driving Dynamics
 - DSC mode: Increased driving dynamics and maximum traction. Thanks to more precise and faster control interventions, the driver can further extend the boundaries of driving dynamics while retaining vehicle safety.
 - DTC mode: Compared to DSC mode, Dynamic Traction Control (DTC) allows for increased slip at the drive wheels to provide maximum propulsion when driving off in snow for instance. In addition, the stabilizing control interventions cut in later in DTC mode thus allowing a more sport-oriented driving profile.
- Active Safety
 - The additional functions of brake standby, dry braking and fading assistance shorten the stopping distances.
 - Increased DSC efficiency makes for more effective safety-relevant functions.
- Comfort
 - Improved operating comfort (brake interventions are less audible, pedal vibration is drastically reduced) through the use of a 6-piston pump in connection with a new higher-frequency electrical actuation system.
 - Additional functions such as start-off assistant and parking brake provide increased driver assistance and comfort.

Classic Brake Control Functions

- Antilock Braking System (ABS)

ABS prevents individual wheels from locking while braking by targeted modulation of the braking pressures. The steerability of the vehicle through the front wheels is largely retained. When braking on road surfaces with different coefficients of friction, the straight-ahead position is stabilized in co-operation with the active steering (option).

- Cornering Brake Control (CBC)

(CBC) keeps the vehicle under control when braking lightly in fast corners by asymmetric control of the braking pressure, thus improving the cornering stability.

- Automatic Stability Control (ASC)

(ASC) prevents spinning of the drive wheels by way of specific brake application and influencing the drive torque delivered by the combustion engine thus optimizing the forward propulsion of the vehicle.

- Dynamic Brake Control (DBC)

If an emergency braking operation is initiated by the driver, the system assists the driver by automatically applying the maximum braking pressure immediately in order to optimize the braking effect.

- Automatic Differential Brake (ADB-X)

ADB-X replicates the function of the differential locks: if a wheel tends towards spinning, it is automatically braked so that forward propulsion can still be achieved through the other wheel on the axle.

- Dynamic Stability Control (DSC)

A vehicle which tends to understeer or oversteer is stabilized by specific brake intervention on individual wheels. This function operates on the E70 together with the active steering (option).

- Hill Descent Control (HDC)

HDC automatically applies the brakes at individual wheels when driving downhill at low speed, particularly on poor surfaces such as sand, gravel or snow. The function is activated by means of a button in the center console.

- Trailer Stabilization Logic

This function automatically detects when a vehicle with a trailer begins to sway and it stabilizes the vehicle-trailer combination by specific brake intervention thus reducing the speed to below the critical shear/swerve level.

Additional Brake Control Functions

- Dynamic Traction Control (DTC)

DTC represents a special mode of DSC which, while interacting with (ASC), (ADB-X) and xDrive, realizes maximum propulsion on loose surfaces such as snow, sand or gravel, by extending the slip thresholds. The stabilization interventions in connection with DTC cut in later than with DSC thus enabling a more sport-oriented driving profile.

- Brake Standby

This function builds up a moderate braking pressure in the system when the driver very quickly takes his/her foot off the accelerator pedal. The braking effect then cuts in faster to assist the driver in emergency braking.

- Dry Braking

This function lightly applies the brake pads at specific intervals depending on the operation of the windscreen wiper in order to dry the brake discs. This distinctly improves the braking effect in braking operations.

- Fading Assistance

This function assists the driver in applying the braking force when the brake temperature is very high due to an extreme driving profile which requires a higher braking force in order to achieve the required braking effect.



- Start-off Assistant

The start-off assistant holds the vehicle on gradients for about 1.5 seconds after the driver has taken his/her foot from the brake. In this way, the driver can conveniently operate the accelerator pedal without the vehicle rolling back.

- Electromechanical Parking Brake (EMF)

The EMF is a parking brake that can be applied and released by means of a bidirectional button. Depending on the respective vehicle operating situation, the holding force is applied either hydraulically via the DSC or mechanically via EMF.

DSC Functions

Function	Can be switched on/off by driver	DSC ON	DTC	DSC OFF
				
ABS		●	●	●
EBV		●	●	●
CBC		●	●	●
MSR		●	●	●
ASC		●	X	
ADB-X		●	●	●
DSC	⊕	●	X	
HDC	⊕	●	●	●
Dry braking		●	●	●
Start assist		●	●	●
Braking readiness		●	●	●
Fading assistance		●	●	●
DBC		●	●	●
- DBS		●	●	●
- MBS		●	●	●
EMF [parking brake]	⊕	●	●	●
GRR+ (included in active steering option)		●	●	●
RPA		●	●	●
CBS		●	●	●

Symbols:

● = System active

X = System with elevated control thresholds

⊕ = Can be switched on/off

Basic Functions of the EMF

The parking brake (EMF) has two different functions, depending on the operating status of the vehicle.

- Parking brake mode
 - When the engine is running or the vehicle is rolling, the parking brake acts on the service brake with the aid of the DSC hydraulics. This means the brake units on the front and rear axle are active.
 - If the engine is not running and the vehicle is stationary, the electromechanical actuator and its cable assembly ensure the parking brake acts on the duo-servo drum brake on the rear axle. In this case, the vehicle is braked as defined in the control unit.
- Dynamic braking

Defined retardation is triggered via the DSC system if the parking brake button is pulled up while driving. The retardation or deceleration is monitored by the DSC control functions and takes place for as long as the parking brake button is pulled.

Emergency Release

A mechanical emergency release facility is provided in order to be able to release the parking brake in the event of the electromechanical actuating unit failing or insufficient power supply.

CAUTION!!!

Secure vehicle to prevent it rolling before operating the emergency release!

The release procedure is performed manually with the emergency release cable assembly and the emergency release handle from the vehicle tool kit. The emergency release procedure releases the duo-servo drum brake by way of mechanical intervention in the actuator of the electromechanical control unit.

Note: After a power failure, it may still not be possible to move the vehicle even after releasing the brake with the emergency release facility. The parking lock of the automatic gearbox may still be engaged (see Product Information Automatic Gearbox E70).

Once released, using the emergency release facility, the parking brake cannot be reactivated manually. The function can be restored only by way of electrical activation.

Restoring Operation After Emergency Release

After turning on the ignition, push down the EMF operating button and pull up again to activate the parking brake.

Service Functions

After replacing the brake shoes of the duo servo drum brake as part of repair or maintenance procedures, the new brake shoes must be bedded-in to ensure adequate holding effect of the new brake shoes. The software of the EMF control unit features a "bedding-in" service mode that must be activated in this case with the BMW diagnostic system.

Indicator/warning lamps in the instrument cluster signal the operating status as well as system fault situations. In the event of faulty signals, the system causing the problem enters corresponding fault codes in the control unit and the system is partially or totally shut down corresponding to the situation. The driver receives additional information on any restricted functions in the control display.

Note: It is only possible to coast or push the vehicle with the transmission in position N. Neutral usually remains selected for a maximum of 30 minutes. If the vehicle is stationary for longer, the automatic transmission parking lock will automatically be engaged.

Example Scenarios

Basic function of the parking brake controlled by the actuating unit Scenario: "Ignition ON", the engine is not yet running and the foot brake is pressed.

With the vehicle stationary, the parking brake is released or applied by pulling or pressing the EMF button. The indicator lamp in the instrument cluster either goes out or lights up red.

Note: The parking brake can be released only with the foot brake pressed when the engine is running or turned off.

The dynamic braking function is triggered if the EMF operating button is pulled while the vehicle is rolling.

Transition from EMF Actuating Unit to DSC

The system switches over from mechanical to hydraulic mode when the engine is started. If the EMF actuating unit was applied at the time, the DSC hydraulics will assume control of the braking force. The EMF actuating unit is not released until the hydraulics are holding the vehicle secure. The indicator lamp remains lit red throughout this process, and the driver is unaware of the transition (the lamp does not even flash).

Transition from DSC to EMF Actuating Unit

The transition to the EMF actuating unit always takes place on exiting the hydraulic function at "ignition OFF". If the parking brake was applied, the hydraulics are not released until the EMF actuating unit is applied. The indicator lamp remains red throughout this transition.

Function of the Parking Brake Controlled by the DSC Hydraulics

Scenario: "Engine running"

The parking brake is applied or released completely by hydraulic means when the EMF operating button is pulled or pressed.

Dynamic braking (hydraulic) is triggered with the vehicle rolling and the button operated at $v > 3$ km/h. The basic functions mainly correspond to the functional scope of a conventional mechanical parking brake.

The system switches between "brake applied" and "brake released" with pressure build-up and pressure reduction every time the EMF button is pulled or pressed.

The parking brake must be released by pressing the EMF button before starting off. Pulling away against the applied brake pressure results in an increase in pressure and a warning to the driver.

Scenario: "At rest"

Remove control removed The parking brake enters rest status when the remote control is removed. If the parking brake is applied, the time-delayed red indicator lamp signals this status to the driver.

If the EMF actuating unit is released in rest mode, the EMF actuating unit is applied when the EMF button is pulled with the vehicle stationary. If the vehicle is in motion, pressing the button will initiate dynamic braking.

Note: Always take the remote control with you when leaving the vehicle otherwise children could release the parking brake.

Dynamic Braking

Two braking units for brake operation are required by law (previously: foot brake and hand brake) In the E70, the second operating point besides the foot brake is the EMF button on the gear selector lever.

The vehicle is braked by the drum brakes at the rear axle if the EMF button is pressed and held at speeds below $v = 3$ km/h and with the engine switched off.

The vehicle is braked at a rate of 3 m/s^2 for 0.8 seconds if the EMF button is pressed when the vehicle is in motion. Braking power is then ramped up to 5 m/s^2 for the next 2 seconds. This braking action is retained for as long as the EMF button is pulled.

For stability reasons (over-braking - rear axle) the dynamic braking function is also triggered in the rest state in response to the vehicle rolling (engine turned off, ignition OFF) by means of active pressure build-up by the DSC hydraulics together with the DSC function. The brake pressure required is made available as rapidly as possible.

The braking action is always monitored by the DSC control function. This ensures vehicle stability while braking. Since all four wheels are braked hydraulically, there is considerably greater deceleration with a minimum of operating effort (EMF button) by comparison with conventional parking brakes. The controlled brakes are therefore able to contribute to improving vehicle safety.

For traffic safety reasons, operation of dynamic braking is indicated to the road users behind by the brake lights coming on.

To avoid accidental operation and misuse, the driver is notified of dynamic braking operation by a display message and gong.

This function is intended only for use in an emergency and must never be used as a substitute for normal operation of the service brake.

The more effective braking solution is used if the parking brake deceleration request is overlapped by the brake pedal being depressed. The DSC control unit decides which deceleration request is to be carried out.

Exiting Dynamic Emergency Braking

The vehicle will remain hydraulically braked even after the EMF button has been released if the vehicle is braked to a halt by dynamic braking. There is a transition to the normal DSC hydraulics function. The hydraulic brake is only released when the EMF button is pressed once more.

If the EMF button is pressed while the vehicle is still in motion, the system level prevailing before the emergency dynamic braking was activated is resumed. If the parking brake is released and the vehicle is coasting, it is possible to activate emergency dynamic braking in any situation (terminal 30, 15, R) by pressing the EMF button.

Error Messages

All fault statuses are detected by the monitoring system and displayed to the driver. The main aim is to avoid safety-critical conditions for vehicle occupants, the vehicle and its surroundings.

A fault can be assigned different priorities depending on the driving situation (vehicle stationary/in motion, starting/stopping) and the system availability. In addition to the indicator lamp, supplementary instructions may be shown in the control display.

To avoid additional damage, faults in the parking brake mechanism, particularly a broken cable in the operating cable assembly and excess load are detected by the force sensor and indicated accordingly. See shutdown strategy table.

Error messages can no longer be output actively in the event of the EMF control unit failing. In this case, the instrument cluster assumes the control of the correct error message on recognizing the absence of the regular EMF telegram via the PT-CAN (alive signal).

Shut-down Strategy			
Fault	Availability		Back-up System
	Parking brake (mechanical) $v = 0$	Dynamic braking (hydraulic) $v > 0$	
CAN signal	OK	OK	
DSC hydraulics	OK	NA	Service brake + hand brake
Actuating mechanism	NA	OK	Park position automatic gearbox
EMF control unit	NA	NA	Park position automatic gearbox and service brake and auxiliary brake if necessary

General Parking Brake Fault Concept

Fault Distribution Between DSC and EMF Control Unit

Only DSC faults that actually affect operation of the parking brake result in shut-down of the hydraulic function. These are mainly faults that result in shut-down of the ABS functionality. They trigger the transition to manual emergency mode. Dynamic braking is no longer possible unless only CAN faults occur affecting this functionality.

-
- Shut-down level "electromechanical mode"
(only EMF actuating unit) initiated by following DSC faults
 - DSC control unit fault
 - Electrical fault (e.g. wiring harness)
 - Sensor fault (brake light switch/wheel speed)
 - actuator fault/hydraulic unit
 - Bus communication fault
 - Shut-down level "electrohydraulic mode"
(failure of EMF actuating unit)
 - Force sensor fault
 - Actuator fault of EMF actuating unit
 - Error in actuation electronics
 - Fault in actuating mechanism
 - Electrical fault
 - Shut-down level "total shut-down"
 - EMF control unit or controller fault
 - EMF button fault
 - Electrical fault, power supply

Note: All fault codes are stored in the control unit in which the monitoring routine was performed. The EMF control unit is informed of the fault status of the DSC control unit and vice versa.

Fault Regeneration

When a fault is detected, the system remains in a safe mode until the end of the "ignition ON" cycle, once reached, a shut-down level is not cancelled during the cycle.

A shut-down status can only be cancelled when a corresponding check beforehand guarantees that the component previously detected as faulty is functioning correctly. For this reason, such component tests are also performed in shut-down mode. The fault information is retained in the fault code memory. The shut-down status is then cancelled when a new "ignition ON" cycle is started.

If correct operation of the component cannot be determined after a fault, the parking brake will remain in the secure, shut-down state until the next workshop visit where the fault code can be deleted by the diagnostic unit after a repair.

Monitoring and Fault Detection

- Monitoring of electrical faults:

Breaks (open circuits) and short-circuits with respect to ground and U-batt of all cables leading to the control unit as well as short-circuits in the actuator or its cables are detected and dealt with accordingly. If possible, this also applies to short-circuits of neighboring connector pins.

External breaks or short-circuits do not result in irreparable damage to the control unit.

- Monitoring input signals:

All input variables of the parking brake are monitored. In the event of a fault occurring, the complete system is shut down with a corresponding error message and fault code entry.

- Monitoring EMF button:

The EMF button has a redundant layout for diagnosis. The signal levels of this component are permanently monitored. In the event of a plausibility error, the complete system is shut down with a corresponding fault code entry.

The DSC control unit also checks the plausibility of the signals from the EMF button. Signal level errors result in a corresponding fault code entry with partial shut-down. Dynamic braking is now no longer possible.

- Monitoring vehicle speed signals:

The parking brake system is totally shut down only when all 3 speed inputs have failed or are not available

- The direct digital wheel speed signal, also known as the discrete speed signal, is permanently checked in terms of plausible signal edge change.
- A mutual plausibility check of the reference speed made available from the DSC via the PT-CAN and the discrete speed signal is constantly performed.
- The reference speed is the mean wheel speed from the DSC which is compared with the transmission output speed sent by the EGS.

System Components.

Hydraulic Unit with Add-on Control



Index	Explanation
1	Hydraulic unit with DSC control unit

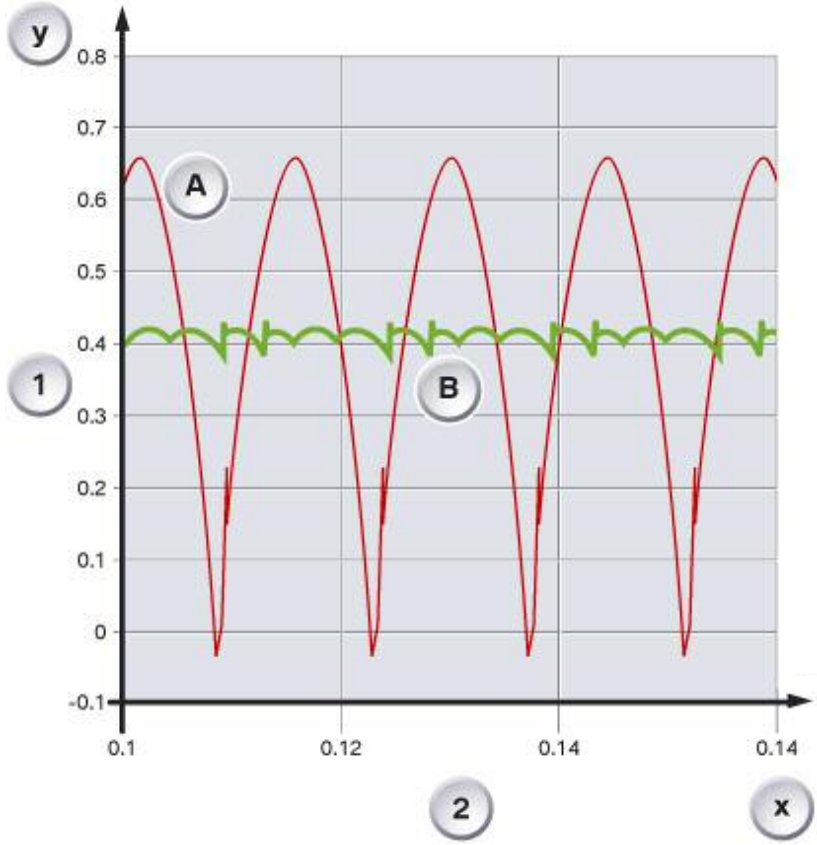
With its new pump concept, the hydraulic unit provides a significant improvement in control accuracy. 2 x 3 pump elements with a diameter of 6.5mm and intake-optimized units operate in the hydraulic unit. This pump concept ensures substantially improved pressure dynamics resulting in lower pedal feedback in ABS mode and higher control quality in HDS.

For the driver this is noticeable in as far as the pedal pulsation can now only be felt very slightly during ABS braking. There is a pressure sensor in the hydraulic unit.

DSC Control Unit

The DSC control unit can be replaced individually. The 47-pin connector connects the DSC control unit to the engine wiring harness.

Volumetric Flow of Hydraulic Unit

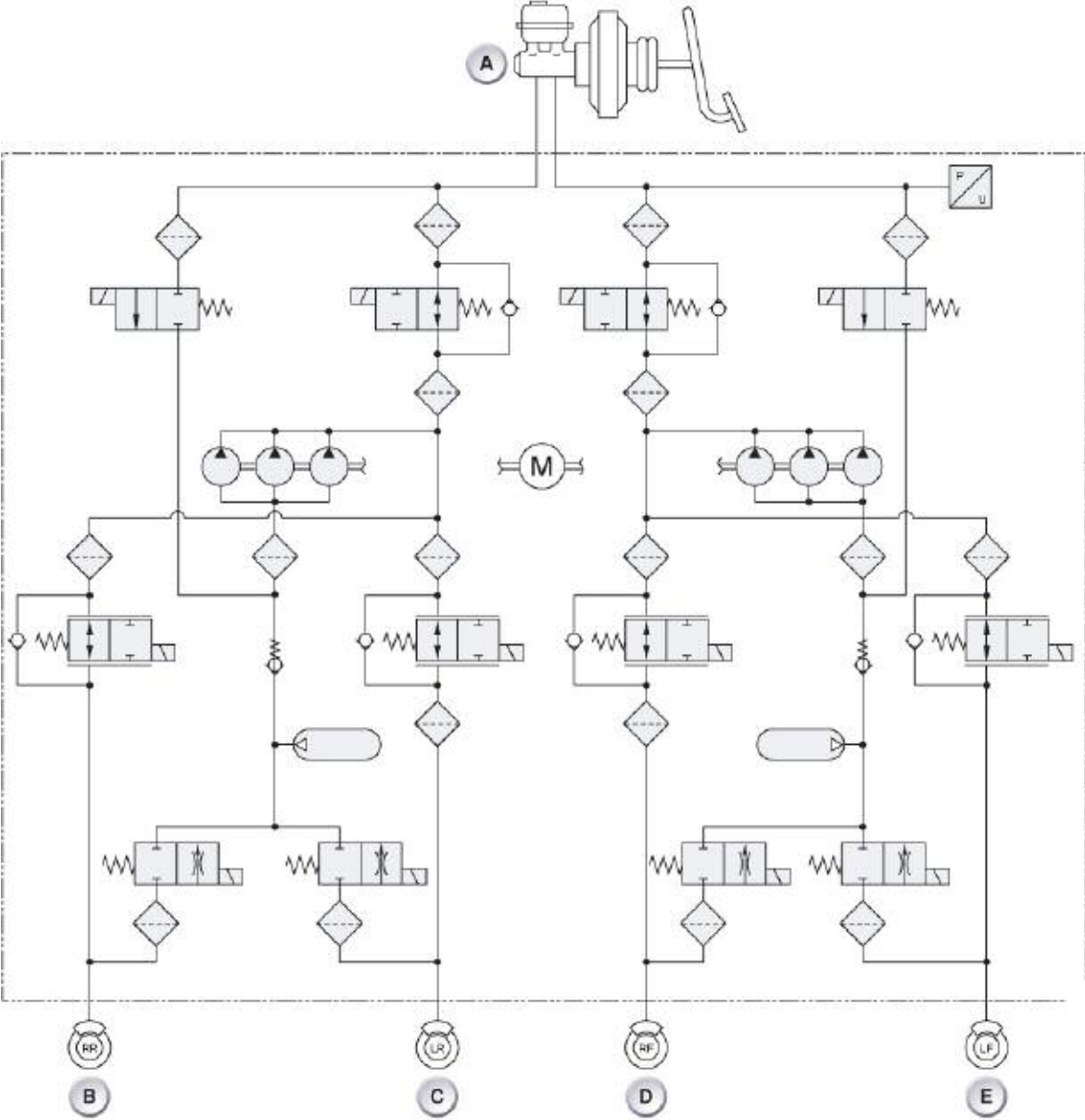


Index	Explanation
1	Q [l/min] Liters per minute
2	t [s] at Qmean = constant
A	DSC8
B	DSC E7x

NOTES

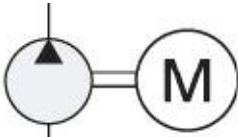
PAGE

Hydraulic Diagram DSC E70

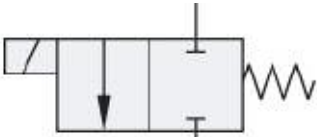


Index	Explanation	Index	Explanation
A	Master brake cylinder	D	Front right brake
B	Rear right brake	E	Front left brake
C	Rear left brake		

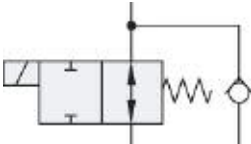
Legend for Hydraulic Symbols



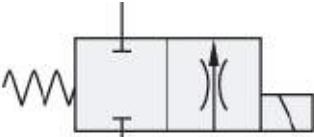
Electrically operated hydraulic pump



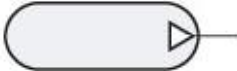
2/2-way valve



2/2-way valve with non-return valve



Outlet valve



Hydraulic accumulator



Filter



Pressure sensor



Non-return valve

Wheel Speed Sensor

4 active wheel speed sensors are installed in the E70. All 4 sensors have a direct hard-wired connection to the DSC control unit.

These active wheel speed sensors facilitate recognition of the direction of rotation, air gap (clearance) and standstill. The DSC control unit receives this information in the form of a PWM signal.



Index	Explanation
1	Sensor ring/ferromagnetic wheel bearing seal carrier
2	IC sensor with Hall sensor
3	Sensor housing

Main Features of the Active Wheel Speed Sensor

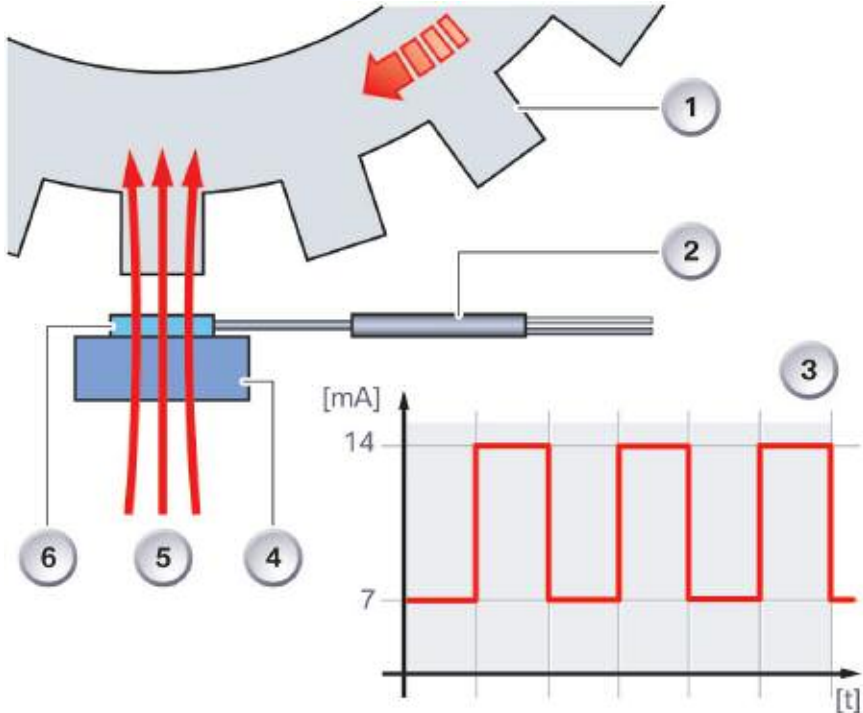
- Location recognition:
Indicates whether the change in magnetic field strength can be guaranteed for correct operation with a high degree of certainty. This signal is no longer required after approximately 20 km/h / 12 mph.
- Stationary recognition:
The power supply is switched on if the wheel is stationary for more than 1 second. A signal is sent to the DSC control unit every 740ms so that the availability of the sensor can be checked.
- Speed signal:
This is a frequency-dependent signal for determining the speed of the wheel.
- Direction of rotation recognition:
Indicates the direction of rotation, clockwise / counterclockwise.
- Air gap reserve:
Indicates whether the change in magnetic field strength is below the necessary value for correct operation.

A two-wire line is used to transfer the signal. This two-wire interface is a combined earth and data line.

The permanent magnet in the wheel speed sensor generates a magnetic field. The lines of the magnetic field run perpendicular to the sensor layer on the sensor element.

The deviation of the fields lines caused by the increment wheel produces changes in resistance in the thin ferromagnetic layer of the sensor element.

Function of Active Wheel Speed Sensor



Index	Explanation	Index	Explanation
1	Increment wheel	4	Permanent magnet
2	Electronic evaluation unit	5	Magnetic field lines
3	Signals from the wheel speed sensor	6	Sensor element

Steering Column Switch Cluster

The Steering Column Switch Cluster (SZL) consists of the following components:

- SZL electronics
- Steering angle sensor
- Steering column stalk, cruise control
- Steering column stalk, direction indicator
- Steering column stalk, wiper
- Coil spring assembly

The steering column switch cluster can only be replaced as a complete unit. The coil spring assembly is fitted on the steering column switch cluster. The spring coil assembly can be removed and replaced individually.



Index	Explanation	Index	Explanation
1	Steering column stalk, direction indicator	4	Steering column switch cluster with optical sensor
2	Steering column stalk, cruise control	5	Steering column wiper stalk with buttons for rain/driving light/solar sensor
3	Code disc		

SZL Electronics

The SZL electronics consists of a processor, the power supply and following interfaces:

- F-CAN
- Optical switches
- Electrical switches

The optical sensor for measuring the steering angle is integrated in the pc-board of the control unit.

Steering Angle Sensor

The steering angle sensor is designed as a contactless, optical angle measuring system. The system consists of a code disc and an optical sensor. The code disc is connected by means of a driver to the steering wheel. The code disc turns within the optical sensor as the steering wheel is turned.

Code Disc

The code disc is black and features a line pattern. This pattern consists of two continuous lines on the outside and inside of the code disc.

There are broken lines located at defined intervals between the two continuous lines. These lines represent the digital area of the sensor. The digital code changes every 2° .

The oblique lines in the outer zone represent the analogue area of the sensor. These lines permit precise measurement (0.1°) of the steering angle.



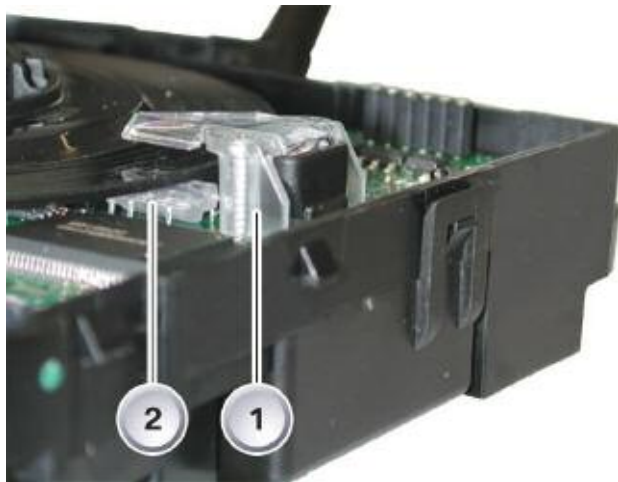
Index	Explanation
1	Optical sensor
2	Code disc

Optical Sensor

The optical sensor is designed as follows: LED and fibre optics unit The LED in connection with the fibre optics unit has the task of projecting light from the top onto the code disc. The LED is soldered directly to the pc-board of the (SZL). The fibre optics unit is secured by means of two screws to the pc-board. Together, the LED with fibre optics unit and the line camera make up the optical sensor.

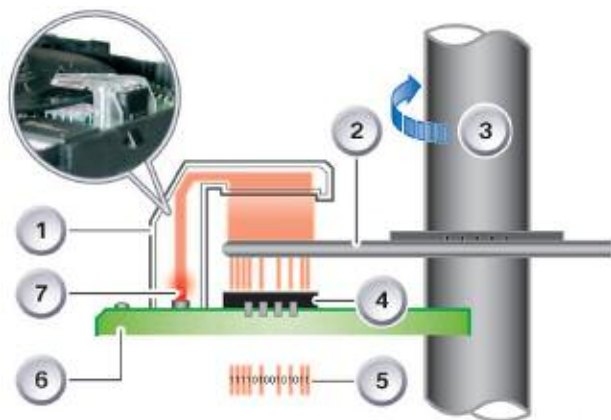
Line Camera

The line camera is located beneath the code disc. The line camera converts optical signals that penetrate through the code disc into electrical signals.



Index	Explanation
1	Line camera
2	Fibre optics unit with LED

Index	Explanation
1	Fibre optics unit
2	Code disc
3	Steering column
4	Line camera
5	Output: Conversion to electrical signals
6	PC-board
7	Light-emitting diode



DSC Sensor



Index	Explanation
1	DSC sensor

The DSC sensor is located under the front passenger seat and is available in two variants in the E70:

- Vehicle without active steering, DSC sensor (designation MM3.8), containing a
 - Transverse acceleration sensor.
 - Longitudinal acceleration sensor.
 - Yaw rate sensor in a housing.
- Vehicle with active steering, DSC sensor (designation MM3.2.2), containing.
 - 2 redundant transverse acceleration sensors.
 - Longitudinal acceleration sensor.
 - 2 redundant yaw rate sensors in a housing.

Electromechanical Parking Brake (EMF)

EMF Button

On the E70, the EMF button or the parking brake is located in the center console next to the gear selector lever.



Index	Explanation
1	EMF button

The EMF button is based on the function logic of a hand brake.

- Pull EMF button (1) up: Parking brake is activated
- Press EMF button (1) down: Parking brake is deactivated

Note: The indicator lamp in the instrument cluster shows the driver when the EMF is activated.



Emergency Release



Index	Explanation
1	Bowden cable, emergency release EMF
2	Handle for emergency release

The E70 tool kit is located in the luggage compartment which includes a red handle for the emergency release (2) of the EMF and the parking lock of the automatic gearbox. The EMF emergency release cable (1) is located on the rear left behind the side trim panel.

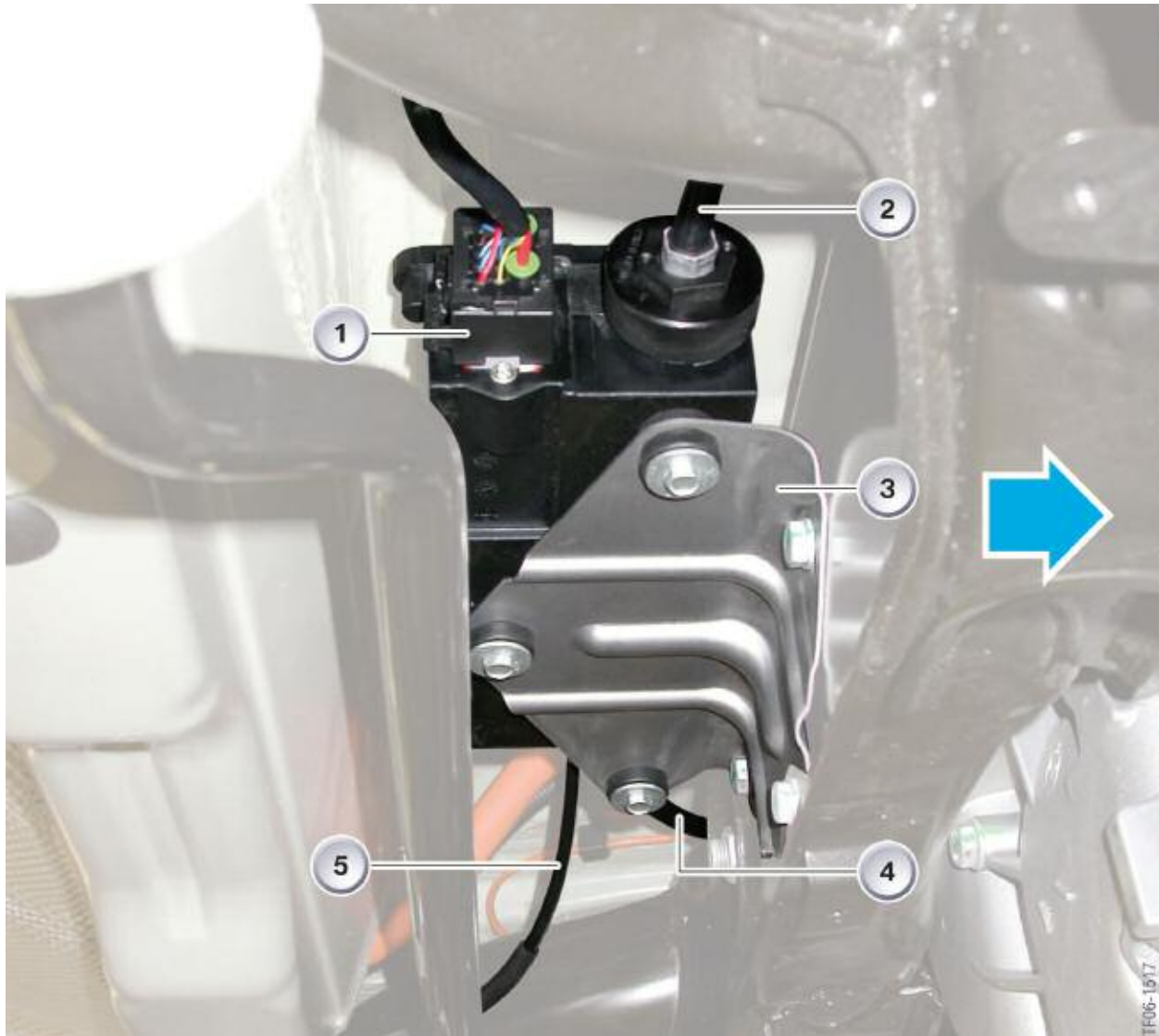
■ Using the E70 EMF Emergency Release



Index	Explanation
1	Handle for emergency release
2	Bowden cable, emergency release EMF

The opening in the handle for the emergency release (1) is attached to the EMF emergency release cable as illustrated and the parking brake is released in the electromechanical actuating unit by pulling the handle upwards.

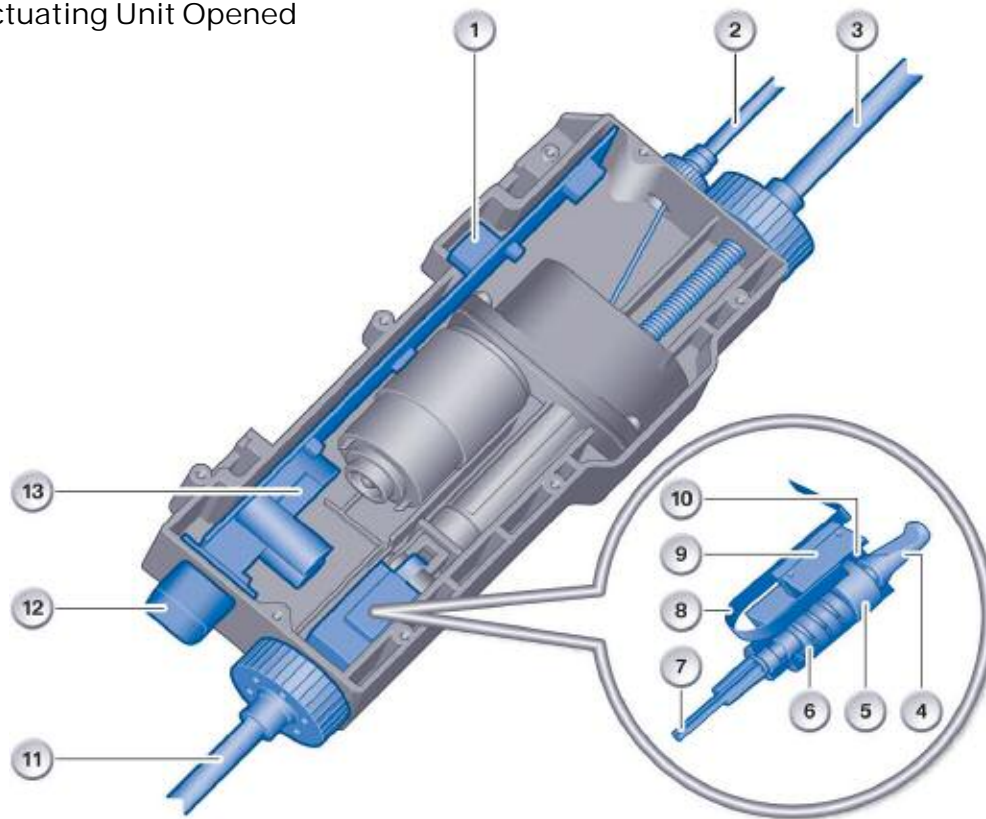
Electromechanical Actuating Unit



Index	Explanation	Index	Explanation
1	Electrical connection	4	Bowden cable, rear left wheel
2	Bowden cable, rear right wheel	5	Bowden cable, emergency release
3	Component carrier		

On the E70, the EMF actuating unit is located on the component carrier (3) on the rear axle.

■ EMF Actuating Unit Opened



Index	Explanation	Index	Explanation
1	EMF control unit (control electronics)	8	Flexible band
2	Bowden cable, emergency release	9	Force sensor pc-board
3	Bowden cable, rear left wheel	10	Force sensor magnet
4	Lock pin	11	Bowden cable, rear right wheel
5	Actuating piston	12	Electrical connection
6	Spring	13	EMF control unit (control electronics)
7	Emergency release cable		

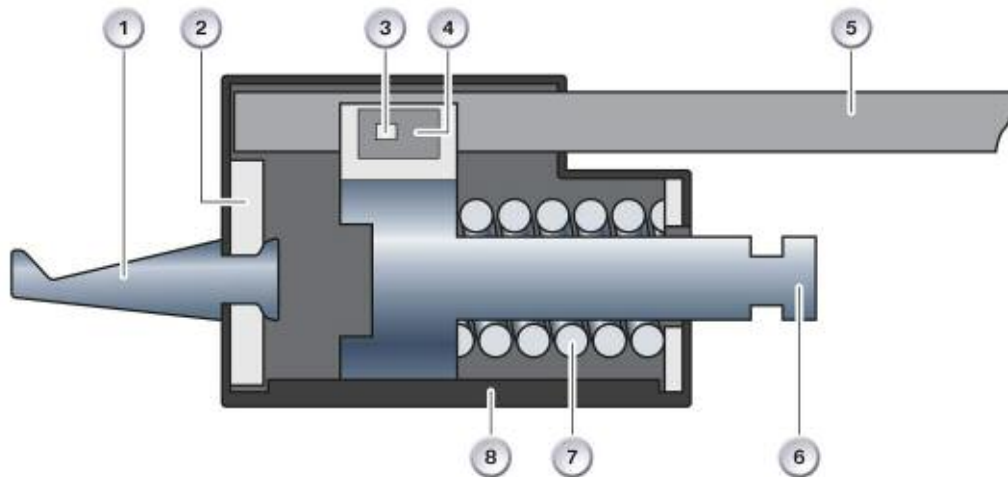
The EMF actuating unit is sealed watertight and the housing cannot be opened.

The EMF actuating unit contains the following main components:

- EMF control unit
- Electric motor
- Spindle gear mechanism
- Force sensor

The force sensor in the EMF actuating unit is a very important component for operation of the parking brake. With its signals, the force sensor makes it possible for the EMF control unit to determine the actuating force. The actuating force is essential for securing the required braking pressure.

■ Force Sensor



Index	Explanation	Index	Explanation
1	Hook	5	Force sensor pc-board
2	Retaining plate	6	Piston
3	Hall-IC	7	Spring
4	Magnet	8	Lower section of housing

The housing of the force sensor consists of two halves. The lower section of the housing (8) is made from pressure diecast aluminum so that it can take up the exerted forces.

The upper section of the housing is made of plastic, to which the force sensor pc-board (5) with the Hall-IC (3) is secured.

The magnet (4) is fixed to the piston (6). The force sensor is located between the left and right bowden cable assembly. During actuation, the piston (6) moves with the magnet against the spring (7).

The travel range of spring compression is measured in accordance with the familiar Hall principle. Since the spring data are defined, the EMF control unit can calculate the applied force from the travel range and the spring data. The force sensor is calibrated at the end of the assembly line.

Cruise Control with Brake Intervention (DCC)

The operating and display philosophy on the DCC steering column stalk and in the instrument cluster in the E70 is the same as that in other model series.

Functionally, the cruise control with brake intervention DCC is integrated in the DSC control unit. The DCC functionality is realized by way of communication with the partner control units of the DSC control unit in the system network such as DME/DDE, EGS, SZL and instrument cluster.



Index	Explanation
1	Button, select stored speed

The DCC function can be activated from 30 km/h/19 mph (up to max. 250km/h/155mph) and is deactivated by similar factors as for cruise control:

- Brake pedal actuation
- Deactivation of DSC
- Activation of DTC
- Active DSC intervention
- Deactivation by the driver
- Speed is reduced below 22 km/h
- "N" engaged
- EMF function activated

DCC achieves a deceleration of max. 2.1 m/s^2 and an acceleration of about 1.7 m/s^2 .

The transverse acceleration is variably limited by the Curve Speed Limiter (CLS). The primary emphasis has been placed on comfortable performance in this system configuration. When cruise control with brake intervention is activated, the brake lights are also activated in accordance with legal requirements in connection with a system related braking operation DCC.

Extended functions of the DCC compared to a conventional cruise control system:

- Active brake intervention to realize the set speed also when driving downhill
- Curve Speed Limiter (CLS) - adaptation of driving speed when cornering (transverse acceleration).

This function limits the maximum transverse acceleration dependent on vehicle speed with the aim of achieving the greatest possible agility in DCC mode. Driving on winding country roads in a speed range from > 50 km/h/31mph to < 120 km/h/74mph is controlled with a value of $3.3 - 3.7$ m/s². The value can increase up to 4.5 m/s for fast highway bends and slow lane changes at speeds between < 50 km/h/31mph and > 120 km/h/74mph.

- Comfort Dynamic System (CDS) - this enables a type of "manual throttle mode" on the steering column stalk.
- Adapted downhill mode - the overrun fuel cutout and gear down shift are correspondingly adapted.

Service Information

Adjusting the Brake Shoes

The procedure for adjusting the parking brake shoes is the same as before:

Turn the adjusting screw using a screwdriver through the threaded hole in the wheel hub (10 teeth).

Removing the Bowden Cable Assemblies

Note: The EMF must be set to service mode with the diagnostic tester before performing any maintenance or service procedures (the parking brake cannot be applied, EMF assumes the outermost position). The EMF will not respond to an operating signal until service mode has been deactivated again.

Necessary preparation:

- To remove emergency release bowden cable assembly in luggage compartment (see Emergency Release). Use pointed pliers to press together the white clip while pressing in the direction of the floor plate.

Remove the wheels, brake calipers and brake discs (according to repair instructions) to expose the duo-servo brake shoes.

The heat shield must be removed on vehicles with Active Roll Stabilization (ARS) and the ARS anti-roll bar lowered. (It is sufficient to release the ARS anti-roll bar at the mounting points and to lower it.)

Unplug the electrical connector from the EMF actuating unit.

- To detach and expose the emergency release bowden cable assembly (Note: Clip fastening behind wheel arch panel). Release spring clip on wheel carrier. Detach nipple of cable assembly from brake shoe expander and pull the cable out of the wheel carrier. Release the cable assembly from the clip on the rear axle carrier and pull in the direction of the EMF actuating unit.
- Detach the carrier for the EMF actuating unit from the rear axle carrier and from the EMF actuating unit and pull out.
- Screw the union nut on the rear left wheel cable assembly by 5-7 turns (left-hand thread) into the spline shaft of the actuator. Then fit the twist lock (square) of the threaded spindle in the guide in the actuator housing. The sleeve of the cable assembly must lie flat on the actuator housing before fitting the union nut. Tighten the union nut to 6 Nm. Attach the rear right wheel cable assembly to the mounting point on the actuator and secure with the clip. Make sure that the cable is firmly fitted. The cable assembly must lie flat on the actuator housing before fitting the union nut. Tighten to 6 Nm.

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- Reinstallation takes place in the reverse order of removal. Fit the new EMF actuating unit, cable assemblies first, in the package space. If it was necessary to slack off the carrier from the EMF actuating unit, it must be resecured to the EMF actuating unit and tightened to a torque of 4 ± 0.5 Nm. The component carrier must be secured to the rear axle carrier to a torque of $19\text{Nm} \pm 15\%$. Before securing the cable assemblies to the wheel carrier (tightening torque 8 Nm), check that the brake cables are securely attached in the brake shoe expander otherwise the EMF actuating unit may be damaged as soon as it is operated.

Start-up

A new EMF actuating unit is always set to "service mode". This mode can be actively reset with the diagnostic tester or it resets itself automatically on exceeding a defined vehicle speed. The actuating unit is now in "standby mode". The EMF actuating unit must then be encoded to the vehicle.

Initializing the Parking Brake

Note: The EMF must be initialized with the diagnostic tester after replacing the drum brake linings.

Bedding in the Duo-servo Brake

If the brake shoes of the duo-servo brake are replaced as part of repair or maintenance work, it is necessary to bed in the brake shoes before a sufficient holding effect may be achieved. Also in this case, the special routine must be activated in the EMF with the diagnostic tester.

The flashing indicator lamp in the instrument cluster signals that the bedding-in program is ready.

The bedding-in program will be aborted and the normal parking brake function resumed if the bedding-in is not started within 30 minutes of program activation or if the ignition is switched off.

The bedding-in procedure can also be performed on the roller dynamometer.

Function on Brake Rolling Dynamometer

The Operation of the E70 parking brake can be tested on the brake rolling dynamometer. As part of the road inspection, the rear axle brake can be tested with the engine running by pulling the EMF button.

As part of the road inspection, the rear axle brake can be tested with the engine running by pulling the EMF button. As a result, the EMF actuating unit is applied, the duo-servo brake is applied and the vehicle normally jumps out of the roller of the test rig.